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N. DeRiggi

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In the application of:

Toshihide SEKIDO et al.

Serial No.: NEW

[National Stage Application of PCT/JP99/05395 filed September 30, 1999]

Filing Date: March 30, 2001

For: FIBER-REINFORCED RESIN STRUCTURE HAVING HOLLOW CROSS SECTION AND MANUFACTURING METHOD THEREOF

Examiner: not assigned

Group Art Unit: not assigned

PRELIMINARY REMARKS

Box PCT
Commissioner for Patents
Washington, D.C. 20231

Sir:

Applicants submit the Amendments of April 28 and October 10, 2000 filed during the International Preliminary Examination. However, these amendments are confusing because the page and line numbers in the Amendment of April 28, 2000 reflect those of the English language PCT application, while the page and line numbers in the Amendment of October 10, 2000 reflect those of the original Japanese application. Applicants do not intend to enter these amendments for U.S. prosecution. Therefore, these amendments should NOT be entered in the

specification and claims of the attached English language application.

Respectfully submitted,

Dated: March 30, 2001

By: ______________________

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WRITTEN AMENDMENT

(Amendment according to the Provision of Section 11 of the Law)

To the Commissioner

1. Indication of International Application: PCT/J99/05395

2. Applicant

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3. Date of notification: 08.08.00

4. Object of amendment: Specification and claims

5. Contents of amendment

(1) "two or more rounds in the circumferential direction." at page 4, line 5 of the specification will amended to read, "two or more rounds in the circumferential direction, and (F) a radially projecting rib is provided on the inner circumferential surface of the main body, or the overall height of at least a part of the cavity is 0.5 m or more and the overall width thereof is 0.7 m or more."

(2) "two or more rounds in the circumferential direction." at page 4, line 21 of the specification is amended to read, "two or more rounds in the circumferential direction, and (H) a radially projecting rib is provided on the inner circumferential surface of the main body, or the overall height of at least a part of the cavity is 0.5 m or more and the overall width thereof is 0.7 m or more."

(3) "the following steps (A) through (D) to be taken in this order." at page 4, line 23 of the specification is amended to read,

"the following steps (A) through (D) to be taken in this order and at least one step selected from a group consisting of the following (a) through (c)."

(4) "thereby impregnating into the preforms."

at page 4/1, line 3 of the specification is amended to read,

"thereby impregnating into the preforms.

(a) To use an inner mold having resin passage grooves on the outer surface thereof for injecting a synthetic resin into the preforms of the reinforcement through the grooves, in the inner mold prearranging step.

(b) To bond the structure obtained after completion of the synthetic resin impregnating step to other identical structures for integration by means of local vacuum molding.

(c) To apply a preform retainer for retaining the preforms between the respective preforms and/or between the preforms and the inner mold when the preforms composed of reinforcing fibers are arranged in the preform arranging step."

(5) The following sentence is inserted between lines 17 and 18, page 7 of the specification.

"The structure of this invention is characterized in that a radially projecting rib is provided on the inner circumferential surface of the main body or that the overall height of at least a part of the cavity is 0.5 m or more and the overall width thereof is 0.7 m or more"

(6) "the following steps (A) through (D) to be taken in this order."

at page 2, line 13 of the specification is amended to read,

"the following steps (A) through (D) to be taken in this order, and at least one step selected from a group consisting of the following (a) through (c)."

(7) "thereby impregnating into the preforms."

at page 20, line 22 of the specification is amended to read, "thereby impregnating into the preforms.

(a) To use an inner mold having resin passage grooves on the outer surface thereof for injecting a synthetic resin into the preforms of the reinforcement through the grooves, in the inner mold prearranging step.

(b) To bond the structure obtained after completion of the synthetic resin impregnating step to other identical structures for integration by means of local vacuum molding.

(c) To apply a preform retainer for retaining the preform between the respective preforms and/or between the preforms and the inner mold when the preforms composed of reinforcing fibers are arranged in the preform arranging step."

(8) "preforms of the reinforcement through the grooves."

at page 21, line 16 of the specification is amended to read, "preforms of the reinforcement through the grooves (in the former production process, this may be essential in an embodiment)."

(9) "composed of reinforcing fibers are arranged."

at page 21, line 29 of the specification is amended to read, "composed of reinforcing fibers are arranged (this may be essential in an embodiment). "

(9) "identical structures for integration by means of local molding."

at page 21/2, line 1 of the specification is amended to read, "identical structures for integration by means of local molding (this may be essential in an embodiment)."

(10) Claims 1, 2, 5, 7, 28, 37-43 and 44 are amended as per the attached documents (pages for replacement).

6. List of attached documents

(1) Pages 4, 4/1, 4/2, 7, 7/1, 20, 20/1, 21 and 21/1 of the specification

(2) Pages 36, 36/1, 37, 37/1, 40, 40/1, 41 and 42 of the claims

the cavity to the maximum width (f) of the mouth is 1.1 to 500,
(D) the main body has a hollow section, the whole of which is formed as an integral structure substantially free from any bonded region,
(E) the reinforcing fibers of the main body do not substantially have those continuously extending for two or more rounds in the circumferential direction, and
(F) a radially projecting rib is provided on the inner circumferential surface of the main body, or the overall height of at least a part of the cavity is 0.5 m or more and the overall width thereof is 0.7 m or more.

Another embodiment of the fiber reinforced resin structure having a hollow section of this invention is a fiber reinforced resin structure, characterized in that
(A) the structure consists of a plurality of elements,
(B) at least one of the elements is a structure provided with at least one mouth and a main body having a cavity therein and has a solid of non-revolution as a section thereof,
(C) the mouth is positioned at an end of the structure consisting of a plurality of elements,
(D) the inner maximum width (F) of the cavity is 0.5 m or more and the ratio (F/f) of the inner maximum width of the cavity to the maximum width (f) of the mouth is in a range of 1.1 to 500,
(E) the main body is composed of a fiber reinforced resin formed by impregnating reinforcing fibers with a synthetic resin,
(F) the main body has a closed space formed in a section in the circumferential direction at least at one point and has a hollow section having a portion formed as an integral structure substantially free from any bonded region,

(G) the reinforcing fibers of the main body do not substantially have those continuously extending for two or more rounds in the circumferential direction, and

(H) a radially projecting rib is provided on the inner circumferential surface of the main body, or the overall height of at least a part of the cavity is 0.5 m or more and the overall width thereof is 0.7 m or more.

One embodiment of the process for producing a fiber reinforced resin structure having a hollow section of this invention is a process for producing a fiber reinforced resin structure having a hollow section comprising at least the following steps (A) through (D) to be taken in this order and at least one step selected from a group consisting of the following (a) through (c).

(A) An inner mold prearranging step for arranging an inner mold having a solid of non-revolution as a section thereof on a mount.

(B) A preform arranging step for arranging preforms partially or wholly composed of reinforcing fibers on the surface of the inner mold to ensure that the reinforcing fibers are not arranged to continuously extend for two or more rounds around the inner mold.

(C) A pressure reducing step for covering the tops of the preforms on the surface of the inner mold with a bag and reducing the pressure in the bag to lower than atmospheric pressure.

(D) A synthetic resin impregnating step for injecting a synthetic resin into the reinforcing fibers, for uniformly diffusing the resin in the surface direction of the preforms of the reinforcement, for impregnation into the preforms.

(a) To use an inner mold having resin passage grooves on the outer surface thereof for injecting a synthetic resin into the preforms of the reinforcement through the grooves, in the inner mold prearranging step.

(b) To bond the structure obtained after completion of the synthetic resin impregnating step to other identical structures for integration by means of local vacuum molding.

(c) To apply a preform retainer for retaining the preforms between the respective preforms and/or between the preforms and the inner mold when the preforms composed of reinforcing fibers are arranged in the preform arranging step.

Another embodiment of the process for producing a fiber reinforced resin structure having a hollow section of this invention is a process for producing a fiber reinforced resin structure having a hollow section comprising at least the following steps (A) through (F) taken in this order.

(A) An inner mold prearranging step for arranging a hollow inner mold having a solid of non-revolution as a section thereof and made of an elastic material on a support mount.

(B) A resin diffusing medium arranging step for arranging a resin diffusing medium having a function to diffuse a resin, at least on a part of the outer surface of the inner mold.

(C) A preform arranging step for arranging preforms partially or wholly made of reinforcing fibers on the outer surface of the inner mold.

(D) An outer mold arranging step for covering the outer circumference of the preforms composed of reinforcing fibers with an outer mold.

(E) A pressure reducing step for reducing the pressure between the outer mold and the inner mold, to expand or move the resin diffusing medium together with the inner mold toward the outer mold.

(F) A synthetic resin impregnating step for injecting a synthetic resin into the reinforcing fibers, for uniformly diffusing the resin in the surface direction of the preforms of the reinforcement, for impregnation into the preforms.

A further other embodiment of the process for producing a fiber reinforced resin structure having a hollow section of this invention is a process for producing a fiber reinforced resin structure having a hollow section and having a solid of non-revolution as a section thereof, that consists of a plurality of elements, at least one of which is provided with at least one mouth and a main body having a cavity therein,

wherein the elements are bonded to each other with reinforcing fibers arranged to cross over the joints of elements; the joints are locally covered with a bag over the reinforcing fibers; the pressure in the bag is reduced; and a resin is injected for impregnation to bond the elements to each other.

Brief description of the drawings

Fig. 1 is a perspective view showing an example of a hollow FRP structure to which this invention can be applied.

Fig. 2 is a perspective view showing another example of a hollow FRP structure to which this invention can be applied.

Fig. 3 is a perspective view showing a further other example of a hollow FRP structure to which this invention can be applied.

Fig. 4 is a perspective view showing a still further other example of a hollow FRP structure to which this invention can be applied.

Fig. 5 is a perspective view showing a still further other example of a hollow FRP structure to which this invention can be applied.

Fig. 6 is a schematic constitutional view showing an example of the FRP element molding process of this invention.

Fig. 7 is a schematic constitutional view showing another example of the FRP element molding process of this invention.

Fig. 8 is a sectional perspective view showing an example of an interior material forming process using an inner mold having depressed grooves of this invention.

P. 7

With every opening, as described above, the inner maximum width is larger than the maximum width of the mouth. The mouths can also be provided at any other place than both the ends.

Furthermore, it is necessary that the ratio of the inner maximum width to the maximum width of a mouth is in a range of 1.1 to 500. A range of 1.2 to 100 is preferable, and a range of 1.5 to 50 is more preferable. If the ratio is smaller than the lower limit of this range, the inner space is not sufficient, and if larger than the upper limit, it is troublesome to clean or wash the inside in the case of a car body or container, etc. Furthermore, it is preferable that a section, the sectional maximum width (= maximum width in one section) of which is 1.2 times (more preferably 1.5 times) or more of the maximum width of the mouth, exists by 0.1 m (more preferably 0.5 m) or more as the length of the main axis and/or 5% (more preferably 20%) or more of the overall length. In this case, the section satisfying this condition can continue in the same maximum width or in different maximum widths. If the continuous length of the sectional maximum width is less than the lower limit of the range, the inner space is not sufficient, and the human dwelling space may become narrow unpreferably. This condition is especially suitable for an application for transport machines such as aircraft and motor vehicles.

With this shape feature, a relatively large inner space for the size of a mouth can be obtained. On the other hand, with this shape, it is almost impossible to take out the object filling the inner space from the mouth without dividing or deforming it.

The structure of this invention is characterized in that a radially projecting rib is provided on the inner circumferential surface of the main body, or that the overall height of at least

a part of the cavity is 0.5 m or more while the overall width thereof is 0.7 m or more.

The solid of non-revolution in this invention includes a solid of right-and-left symmetry or of up-and-down symmetry. The solid of non-revolution allows various applications as transport machines and various containers. Transport machines include flying objects such as aircraft, airplanes and helicopters, motor vehicles, buses, tracks, motorcycles, bicycles, ships such as passenger boats, sailing boats, motor boats and leisure boats, rolling stock such as passenger coaches and high speed trains, and other distribution machines. As described later, since the hollow FRP structures of this invention are excellent in mechanical properties, they are suitable for large structures of more than several meters.

The hollow FRP structures of this invention include a structure, in which a main component is substantially integrally formed without having any bonded region, and a structure consisting of a plurality of elements, at least one of which has a closed space formed and is substantially integrally formed.

The former does not include a portion bonded by riveting or bolting, etc., and is substantially integrally ..

P. 20

Thermoplastic resins such as .. lene are preferable. Among them, polypropylene containing glass fibers is preferable in view of lamination of the preforms and handling convenience of the inner mold, since the rigidity of the inner mold can be remarkably enhanced. In this case, the adequate amount of glass fibers is 1 vol% to 30 vol%, and the length of glass fibers is about 0.1 to 100 mm in average weight. In the case where an outer mold is used, it is preferable that the outer mold is made of an elastic material like rubber. In the case where the inner mold is removed after molding, it is also

preferable that the inner mold is made of a material with excellent releasability such as silicone rubber.

In the relation with the curing temperature of the resin, it is preferable that the deformation temperature of the inner mold is higher than the curing temperature or temporary curing temperature of the resin. Above all, if the deformation temperature is higher than the curing temperature or temporary curing temperature of the resin by 5℃ or more, it can be inhibited that the inner mold is deformed during the curing or temporary curing of the resin, and the dimensional accuracy of the structure can be secured preferably. The deformation temperature of the inner mold is defined as the Vicat softening point measured according to JIS K 6760.

The hollow FRP structure of this invention can be produced taking at least the following steps (A) through (D) in this order and taking at least one step selected from the following group consisting of (a) through (c).

(A) An inner mold prearranging step for arranging an inner mold having a solid of non-revolution as a section thereof on a mount.

(B) A preform arranging step for arranging preforms partially or wholly composed of reinforcing fibers on the surface of the inner mold to ensure that the reinforcing fibers are not arranged to continuously extend for two or more rounds around the inner mold.

(C) A pressure reducing step for covering the tops of the preforms on the surface of the inner mold with a bag and reducing the pressure in the bag to lower than atmospheric pressure.

(D) A synthetic resin impregnating step for injecting a synthetic resin into the reinforcing fibers, for uniformly diffusing the resin in the surface direction of the preforms of the reinforcement, for impregnation into the preforms.

(a) To use an inner mold having resin passage grooves on the outer surface thereof for injecting a synthetic resin into the preforms of the reinforcement through the grooves, in the inner mold prearranging step.

(b) To bond the structure obtained after completion of the synthetic resin impregnating step to other identical structures for integration by means of local vacuum molding.

(c) To apply a preform retainer for retaining the preforms between the respective preforms and/or between the preforms and the inner mold when the preforms composed of reinforcing fibers are arranged in the preform arranging step.

It is preferable to add a step of curing the whole in a temperature range of 50 to 200℃, for integral molding, further to the above steps.

The hollow FRP structure of this invention can be produced taking at least the following steps (A) through (F) in this order.

(A) An inner mold prearranging step for arranging a hollow inner mold having a solid of non-revolution as a section thereof and made of an elastic material on a support mount, etc.

(B) A resin diffusing medium arranging step for arranging a resin diffusing medium having a function to diffuse a resin, at least on a part of the outer surface of the inner mold

(C) A preform arranging step for arranging preforms partially or wholly made of reinforcing fibers on the outer surface of the inner mold

(D) An outer mold arranging step for covering the outer circumference of the preforms composed of reinforcing fibers with an outer mold

(E) A pressure reducing step for reducing the pressure between the outer mold and the inner mold, to expand or move the resin diffusing medium together with the inner mold toward the outer mold.

(F) A synthetic resin impregnating step for injecting a synthetic resin into the reinforcing fibers, for uniformly diffusing the resin in the surface direction of the preforms of the reinforcement, for impregnation into the preforms.

In this case, it is preferable to take the following steps: covering at least a part of the outer surface of the inner mold, with a sheet-like covering material, arranging preforms partially or wholly composed of reinforcing fibers thereon, covering with an outer mold from the outer circumference, reducing the pressure between the outer mold and the inner mold for expanding or moving the covering material toward the outer mold, and injecting a synthetic resin in this state, for diffusing the resin in the surface direction in the preforms of the reinforcement, thereby impregnating the preforms of the reinforcement with the resin.

In both of the above processes, it is preferable to use a hollow inner mold, and to use an inner mold having resin passage grooves on the outer surface thereof for injecting a synthetic resin into the preforms of the reinforcement through the grooves (in the former production process, this may be essential in an embodiment).

In the latter production process, it is preferable to use an inner mold made of an elastic material, and to pressurize the inside of the inner mold with a fluid, for expanding the inner mold toward the outer mold. In this case, it is preferable that the fluid used for pressurizing the inside of the inner mold is compressed air and that the pressure is in a range of 0.05 to 1.0 MPa (0.5 to 10 kg/cm^2G), more preferably 0.1 to 0.5 MPa.

Also in the former production process, it is preferable to use a resin diffusing medium capable of diffusing the resin into the covering material in the preform arranging step (B). In this case, it is preferable that the medium is a net-like material. It

is preferable that the inner mold is made of any of plastics, rubber, water soluble polymers and wood, and is produced as a hollow inner mold by blow molding. Furthermore, in the preform arranging step (B), it is desirable to apply a preform retainer for retaining the preforms between the respective preforms and/or between the preforms and the inner mold when the preforms composed of reinforcing fibers are arranged (this may be essential in an embodiment). It is preferable to bond the structure to other identical structures for integration by means of local molding (this may be essential in an embodiment).

Furthermore, in both of the production processes, adding an inner mold removing step for removing the inner mold from the integrally molded structure or ..

CLAIMS

1. (As amended) A fiber reinforced resin structure, characterized in that

(A) the fiber reinforced resin structure has a hollow section and is provided with at least one mouth and a main body having a cavity with a maximum width larger than the maximum width of the mouth therein,

(B) the main body is composed of a fiber reinforced resin obtained by impregnating reinforcing fibers with a synthetic resin,

(C) the main body has a solid of non-revolution, in which the inner maximum width (F) of the cavity is 0.5 m or more and the ratio (F/f) of the inner maximum width (F) of the cavity to the maximum width (f) of the mouth is 1.1 to 500,

(D) the main body has a hollow section, the whole of which is formed as an integral structure substantially free from any bonded region,

(E) the reinforcing fibers of the main body do not substantially have those continuously extending for two or more rounds in the circumferential direction, and

(F) a radially projecting rib is provided on the inner circumferential surface of the main body.

2. (As amended) A fiber reinforced resin structure having a hollow section, according to claim 1, wherein the overall height of at least a part of the cavity is 0.5 m or more and the overall width thereof is 0.7 m or more, instead of having a radially projecting rib on the inner circumferential surface of the main body.

3. A fiber reinforced resin structure having a hollow section, according to claim 2, wherein the projecting rib has a core therein and the core is surrounded by a skin layer containing reinforcing fibers, to form a frame structure.

4.

5. A fiber reinforced resin structure having a hollow section, according to any one of claims 1 through 3, wherein a section in the circumferential direction forms a closed space and a portion formed as an integral structure substantially free from any bonded region is positioned at an end or center of the main body.

6.

7. (As amended) A fiber reinforced resin structure, characterized in that

(A) the structure consists of a plurality of elements,

(B) at least one of the elements is a structure provided with at least one mouth and a main body having a cavity therein and has a solid of non-revolution as a section thereof,

(C) the mouth is positioned at an end of the structure consisting of a plurality of elements,

(D) the inner maximum width (F) of the cavity is 0.5 m or more and the ratio (F/f) of the inner maximum width of the cavity to the maximum width (f) of the mouth is in a range of 1.1 to 500,

(E) the main body is composed of a fiber reinforced resin obtained by impregnating reinforcing fibers with a synthetic resin,

(F) the main body has a closed space formed in a section in the circumferential direction at least at one place thereof and has a hollow section having a portion formed as an integral structure substantially free from any bonded region,

(G) the reinforcing fibers of the main body do not substantially have those continuously extending for two or more rounds in the circumferential direction, and

(H) a radially projecting rib is provided on the inner circumferential surface of the main body, or the overall height of at least a part of the cavity is 0.5 m or more and the overall width thereof is 0.7 m or more.

8.

9.

10. A fiber reinforced resin structure having a hollow section, according to claim 7, wherein a radially projecting rib is provided on the inner surface facing the cavity of the structure.

11. A fiber reinforced resin structure having a hollow section, according to claim 10, wherein the projecting rib has a core therein and the core is surrounded by a skin layer containing reinforcing fibers, to form a frame structure.

27. An airplane, comprising the fiber reinforced resin structure having a hollow section as set forth in any one of claims 1-3, 5, 7 and 10-24, as a part thereof.

28. (As amended) A process for producing a fiber reinforced resin structure, comprising at least the following steps (A) through (D) to be taken in this order and at least one step selected from a group consisting of the following (a) through (c).

(A) An inner mold prearranging step for arranging an inner mold having a solid of non-revolution as a section thereof on a mount.

(B) A preform arranging step for arranging preforms partially or wholly composed of reinforcing fibers on the surface of the inner mold to ensure that the reinforcing fibers are not arranged to continuously extend for two or more rounds around the inner mold.

(C) A pressure reducing step for covering the tops of the preforms on the surface of the inner mold with a bag and reducing the pressure in the bag to lower than atmospheric pressure.

(D) A synthetic resin impregnating step for injecting a synthetic resin into the reinforcing fibers, for uniformly diffusing the resin in the surface direction of the preforms of the reinforcement, for impregnation into the preforms.

(a) To use an inner mold having resin passage grooves on the outer surface thereof for injecting a synthetic resin into the preforms of the reinforcement through the grooves, in the inner mold prearranging step.

(b) To bond the structure obtained after completion of the synthetic resin impregnating step to other identical structures for integration by means of local vacuum molding.

(c) To apply a preform retainer for retaining the preforms between the respective preforms and/or between the preforms and the inner mold when the preforms composed of reinforcing fibers are arranged in the preform arranging step.

29.

30.

31.

32. A process for producing a fiber reinforced resin structure having a hollow section, according to claim 28, wherein the whole is cured in a temperature range of 50 to 200℃ for integral molding.

33. A process for producing a fiber reinforced resin structure having a hollow section, comprising at least the following steps (A) through (F) taken in this order.

(A) An inner mold prearranging step for arranging a hollow inner mold having a solid of non-revolution as a section thereof and made of an elastic material on a support mount.

(B) A resin diffusing medium arranging step for arranging a resin diffusing medium having a function to diffuse a resin, at least on a part of the outer surface of the inner mold.

(C) A preform arranging step for arranging preforms partially or wholly made of reinforcing fibers on the outer surface of the inner mold.

(D) An outer mold arranging step for covering the outer circumference of the preforms composed of reinforcing fibers with an outer mold.

(E) A pressure reducing step for reducing the pressure between the outer mold and the inner mold, to expand or move the resin diffusing medium together with the inner mold toward the outer mold.

(F) A synthetic resin impregnating step for injecting a synthetic resin into the reinforcing fibers, for uniformly diffusing the resin in the surface direction of the preforms of the reinforcement, for impregnation into the preforms.

34. A process for producing a fiber reinforced resin structure having a hollow section, according to claim 28 or 33, wherein in the pressure reducing step, the inside of the inner mold is pressurized with a fluid for further expanding the inner mold toward the outer mold.

35.

36. A process for producing a fiber reinforced resin structure having a hollow section, according to claim 34, wherein in the pressure reducing step, the fluid for pressurizing the inside of the inner mold is compressed air and the pressure is in a range of 0.049 to 0.98 MPa (0.5 to 10 kg/cm^2G).

37. (As amended) A process for producing a fiber reinforced resin structure having a hollow section, according to any one of claims 32-34 and 36, wherein in the inner mold prearranging step, an inner mold having resin passage grooves on the outer surface thereof is used for injecting a synthetic resin into the preforms of the reinforcement through the grooves.

38. A process for producing a fiber reinforced resin structure having a hollow section, according to claim 37, wherein the depth of the grooves is in a range of 1 to 50 mm.

39. A process for producing a fiber reinforced resin structure having a hollow section, according to claim 37 or 38, wherein the intervals of the grooves are in a range of 5 to 900 mm.

40. A process for producing a fiber reinforced resin structure having a hollow section, according to any one of claims 37-39, wherein the width of the grooves is in a range of 3 to 5 mm.

41. A process for producing a fiber reinforced resin structure having a hollow section, according to claim 33, wherein in the resin diffusing medium arranging step, a net-like material is used as the resin diffusing medium.

42. A process for producing a fiber reinforced resin structure having a hollow section, according to any one of claims 28, 32-34 and 36-41, wherein the inner mold is made of any one of plastics, rubber, water soluble polymers and wood.

43. (As amended) A process for producing a fiber reinforced resin structure having a hollow section, according to any one of claims 32-34 ad 36-42, wherein said structure is bonded to other identical structures for integration by means of local vacuum molding.

44. (Added) A process for producing a fiber reinforced resin structure having a hollow section, according to any one of claims 32-34 and 36-43, wherein in the preform arranging step, when the preforms composed of reinforcing fibers are arranged, a preform retainer for retaining the preforms is applied between the respective preforms and/or between the preforms and the inner mold.

45. A process for producing a fiber reinforced resin structure having a hollow section, according to any one of claims 28, 32-34 and 36-44, wherein the inner mold used is produced as a hollow inner mold by means of blow molding.

46. A process for producing a fiber reinforced resin structure having a hollow section, according to any one of claims 28, 32-34 and 36-45,

wherein an inner mold removing step for removing the inner mold from the integrally molded structure is provided.

47. A process for producing a fiber reinforced resin structure having a hollow section, according to any one of claims 28, 32-34 and 36-45, wherein the inner mold is left in the integrally molded structure, without being integrated with the structure.

48. A process for producing a plurality of fiber reinforced resin structures respectively having a hollow section and having a solid of non-revolution as a section thereof, that consists of a plurality of elements, at least one of which is provided with at least one mouth and a main body having a cavity therein,

wherein the elements are bonded to each other with reinforcing fibers arranged to cross over the joints of elements; the joints are locally covered with a bag over the reinforcing fibers; the pressure in the bag is reduced; and a resin is injected for impregnation to bond the elements to each other.

Amendment

(Correction based on Article 11 of the Law)

To: Director-General of the Patent Office

1. Identification of the international application
PCT/JP99/05395

2. Applicant
Name: Toray Industries, Inc.
Address: 2-1, Nihonbashi Muromachi 2-chome, Chuo-ku, Tokyo 103-8666
Nationality: Japan
Domicile: Japan

3. Portions to be Corrected: Claims, and Specification

4. Details of Correction

(1) Specification, Page 6, Line 20

"substantially has no regions which are joined."

is corrected as follows:

"substantially has no regions which are joined, and
(E) the reinforcing fibre for the aforesaid main body portion does not virtually extend continuously in the circumferential direction around the portion over a length not less than two times the circumference."

(2) Specification, Page 7, Lines 1-7

"main body portion is composed of fibre-reinforced plastic where

reinforcing fibre has been impregnated with synthetic resin and, furthermore,

(D) the aforesaid main body portion has in at least one location a portion forming a closed space in the circumferential direction section and which is formed as an integral construction substantially having no joined regions."

is corrected as follows:

"opening is located at an end of said structure composed of a plurality of moulded elements,
(D) the maximum internal width of the aforesaid hollow section, (F), is not less than 0.5 m, and the ratio (F/f) of the maximum internal width of the hollow section, (F), to the maximum width of the aforesaid opening ,(f), is in the range of 1.1 to 500.

(E) the aforesaid main body portion is made of fibre-reinforced resin produced by impregnating reinforcing fibre with synthetic resin,

(F) the aforesaid main body portion has in at least one location a portion forming a closed space in the circumferential direction section and which is formed as an integral construction substantially having no joined regions, and

(G) the reinforcing fibre for the aforesaid main body portion does not virtually extend continuously in the circumferential direction around the portion over a length not less than two times the circumference."

(3) Specification, Page 7, between Line ~~7~~ 9 and Line ~~8~~ 10

The following lines are inserted:

"One embodiment of the production method for the fibre-reinforced plastic structure with a hollow section according to the present invention is a method for the production of a fibre-reinforced plastic structure with a hollow section that consists at least of the following stages from (A) to (D) which are carried out in this order:

(A) An inner mould preparation stage in which an inner mould with a cross-section having a non-circular sectional shape is fitted on a stand

(B) A substrate placement stage in which a substrate comprising in part or in total reinforcing fibre is placed on the surface of the aforesaid inner mould in such a manner that the substrate does not extend continuously around the inner mould over a length not less than two times the circumference,

(C) A pressure-reduction stage in which the top of the aforesaid substrate on the surface of the inner mould is covered over with a bag and the interior pressure of said bag is reduced to below atmospheric pressure, and

(D) A synthetic resin impregnation stage in which synthetic resin is injected into the aforesaid reinforcing fibre and the interior of the substrate impregnated by uniform diffusion of said resin in the reinforcing fibre substrate face direction.

Another embodiment of the production method for the fibre-reinforced plastic structure with a hollow section according to the present invention is a method for the production of a fibre-reinforced plastic structure with a hollow section that consists at least of the following stages from (A) to (F) which are carried out in this order:

(A) An inner mould preparation stage in which a hollow inner

mould having a non-circular cross-section and made of flexible material is fitted on a stand,

(B) A resin-diffusing medium placement stage in which a resin-diffusing medium that allows resin to diffuse within it is placed over at least part of the outside surface of the aforesaid inner mould,

(C) A substrate placement stage in which a substrate comprising in part or in total reinforcing fibre is placed on the surface of the aforesaid inner mould,

(D) An outer mould placement stage in which the outer periphery of the aforesaid substrate that has reinforcing fibre on it is covered with an outer mould,

(E) A pressure-reduction stage in which the pressure is reduced in the space between the aforesaid outer mould and the inner mould to expand or move the aforesaid resin-diffusing medium, along with the aforesaid inner mould, in the outer mould direction, and

(F) A synthetic resin impregnation stage in which synthetic resin is injected into the aforesaid reinforcing fibre and the interior of the substrate is impregnated by uniform diffusion of the resin in the plane direction of the reinforcing fibre substrate.

Still another embodiment of the production method for the fibre-reinforced plastic structure with a hollow section according to the present invention is a method to produce fibre-reinforced plastic structures that have a non-circular cross-section and that are composed of a plurality of moulded elements, at least one of the aforesaid moulded elements having at least one opening and a main body portion containing a cavity in its interior, wherein when the aforesaid moulded elements are coupled together, said moulded elements are mutually joined

together by placing reinforcing fibre to straddle the joint regions between the moulded elements, and then placing a bag to locally cover the joint regions from over the reinforcing fibre, followed by reducing the pressure in the bag to ensure resin injection and impregnation."

(4) Specification, Page 32, Line 16

"it is preferred"

is corrected as follows:

"it is necessary".

(5) Specification, Page 36, Lines 13, to Page 37, Line ~~21~~ 14

"(A) An inner mould preparation stage in which an inner mould of cross-section having a non-circular sectional shape is arranged on a stand or the like

(B) A substrate arrangement stage in which substrate comprising in part or in total reinforcing fibre is arranged at the surface of the aforesaid inner mould

(C) A pressure-reduction stage in which the top of the aforesaid substrate is covered over with a bag and the interior pressure of said bag is reduced to below atmospheric pressure

(D) A synthetic resin impregnation stage in which synthetic resin is injected into the aforesaid reinforcing fibre and the interior of the substrate impregnated by uniform diffusion of said resin in the reinforcing fibre substrate face direction

It is preferred that there be added to these stages a stage in

which the entire body is cured within the temperature range 50 to 200°C and integral moulding effected.

The hollow FRP structure of the present invention can also be produced via at least the following stages (A) to (E) in turn.

(A) An inner mould preparation stage in which an inner mould of cross-section having a non-circular sectional shape is arranged on a stand

(B) A substrate arrangement stage in which substrate comprising in part or in total reinforcing fibre is arranged at the outer surface of the aforesaid inner mould"

is corrected as follows:

"(A) An inner mould preparation stage in which an inner mould with a cross-section having a non-circular sectional shape is fitted on a stand

(B) A substrate placement stage in which a substrate comprising in part or in total reinforcing fibre is placed on the surface of the aforesaid inner mould in such a manner that the substrate does not extend continuously around the inner mould over a length not less than two times the circumference,

(C) A pressure-reduction stage in which the top of the aforesaid substrate on the surface of the inner mould is covered over with a bag and the interior pressure of said bag is reduced to below atmospheric pressure, and

(D) A synthetic resin impregnation stage in which synthetic resin is injected into the aforesaid reinforcing fibre and the interior of the substrate impregnated by uniform diffusion of said resin in the reinforcing fibre substrate face direction.

It is preferred that there be added to these stages a stage in which the entire body is cured in the temperature range of 50 to 200°C to form an integral-moulded body.

The hollow FRP structure of the present invention can also be produced by at least the following stages (A) to (F) which are carried out in this order:

(A) An inner mould preparation stage in which a hollow inner mould having a non-circular cross-section and made of flexible material is fitted on a stand,

(B) A resin-diffusing medium placement stage in which a resin-diffusing medium that allows resin to diffuse within it is placed over at least part of the outside surface of the aforesaid inner mould,".

(6) Specification, Page 37, Lines 16 to 23

"C) An outer mould arrangement stage in which the outer periphery of the aforesaid reinforcing fibre arranged substrate is covered by an outer mould

(D) A pressure-reduction stage in which the pressure is reduced between the aforesaid outer mould and the inner mould (E)".

is corrected as follows:

"(C) A substrate placement stage in which a substrate comprising in part or in total reinforcing fibre is placed on the surface of the aforesaid inner mould,

(D) An outer mould placement stage in which the outer periphery of the aforesaid substrate that has reinforcing fibre on it is

covered with an outer mould,

(E) A pressure-reduction stage in which the pressure is reduced in the space between the aforesaid outer mould and the inner mould to expand or move the aforesaid resin-diffusing medium, along with the aforesaid inner mould, in the outer mould direction, and

(F)".

(7) Specification, Page 38, Line 23

"kgG/cm2"

is corrected as follows:

"kgG/cm^2".

(8) Specification, Page 38, Line 32

"preferably employed,"

is corrected as follows:

"preferably employed, the former being more preferred,"

(9) Claims 1, 5, 7, 10-28, 32-34, and 36-43 are corrected.

(10) Claims 4, 6, 8, 9, 29-31, and 35 are deleted.

(11) Claims 44-48 are added.

6. List of attached documents

(1) Specification ~~4, 4/1, 4/2, 18, 20, 21, and 21/1~~ 6, 6/1, 6/2, 7, 7/1, 7/2, 32, 36, 37, 37/1

(2) Claims ~~36-41, 42, and 42/1~~ 38, and 38/1 (63-73 and 73/1).

(A) it is a fibre-reinforced plastic structure with a hollow section which is provided with at least one opening and with a main body portion having in the interior a cavity of maximum width greater than the maximum width of the aforesaid opening(s),

(B) the aforesaid main body portion is composed of fibre-reinforced plastic where reinforcing fibre has been impregnated with synthetic resin and, furthermore,

(C) the aforesaid main body portion has a solid of non-revolution shape where the interior maximum width (F) of the cavity is not less than 0.5 m and the ratio (F/f) of the internal maximum width (F) of the cavity to the maximum width (f) of the aforementioned opening lies in the range 1.1 to 500, and

(D) furthermore, the aforesaid main body portion is formed as an integral construction in which its totality substantially has no regions which are joined, and

(E) the reinforcing fibre for the aforesaid main body portion does not virtually extend continuously in the circumferential direction around the portion over a length not less than two times the circumference.

Another embodiment of the fibre-reinforced plastic structure with a hollow section according to the present invention is a fibre-reinforced plastic structure with a hollow section which is characterized in that

(A) it is composed of a plurality of moulded elements,

(B) at least one of these moulded elements is a structure which is provided with at least one opening and with a main body portion having a cavity in the interior and, furthermore, the section thereof has a solid of non-revolution shape,

(C) the aforesaid opening is located at an end of said structure composed of a plurality of moulded elements,

(D) the maximum internal width of the aforesaid hollow section, (F), is not less than 0.5 m, and the ratio (F/f) of the maximum internal width of the hollow section, (F), to the maximum width of the aforesaid opening ,(f), is in the range of 1.1 to 500.

(E) the aforesaid main body portion is made of fibre-reinforced resin produced by impregnating reinforcing fibre with synthetic resin,

(F) the aforesaid main body portion has in at least one location a portion forming a closed space in the circumferential direction section and which is formed as an integral construction substantially having no joined regions, and

(G) the reinforcing fibre for the aforesaid main body portion does not virtually extend continuously in the circumferential direction around the portion over a length not less than two times the circumference.

One embodiment of the production method for the fibre-reinforced plastic structure with a hollow section according to the present invention is a method for the production of a

(A) An inner mould preparation stage in which a hollow inner mould having a non-circular cross-section and made of flexible material is fitted on a stand,

(B) A resin-diffusing medium placement stage in which a resin-diffusing medium that allows resin to diffuse within it is placed over at least part of the outside surface of the aforesaid inner mould,

(C) A substrate placement stage in which a substrate comprising in part or in total reinforcing fibre is placed on the surface of the aforesaid inner mould,

(D) An outer mould placement stage in which the outer periphery of the aforesaid substrate that has reinforcing fibre on it is covered with an outer mould,

(E) A pressure-reduction stage in which the pressure is reduced in the space between the aforesaid outer mould and the inner mould to expand or move the aforesaid resin-diffusing medium, along with the aforesaid inner mould, in the outer mould direction, and

(F) A synthetic resin impregnation stage in which synthetic resin is injected into the aforesaid reinforcing fibre and the interior of the substrate is impregnated by uniform diffusion of the resin in the plane direction of the reinforcing fibre substrate.

Still another embodiment of the production method for the fibre-reinforced plastic structure with a hollow section according to the present invention is a method to produce fibre-reinforced plastic structures that have a non-circular

(A) An inner mould preparation stage in which a hollow inner mould having a non-circular cross-section and made of flexible material is fitted on a stand,

(B) A resin-diffusing medium placement stage in which a resin-diffusing medium that allows resin to diffuse within it is placed over at least part of the outside surface of the aforesaid inner mould,

(C) A substrate placement stage in which a substrate comprising in part or in total reinforcing fibre is placed on the surface of the aforesaid inner mould,

(D) An outer mould placement stage in which the outer periphery of the aforesaid substrate that has reinforcing fibre on it is covered with an outer mould,

(E) A pressure-reduction stage in which the pressure is reduced in the space between the aforesaid outer mould and the inner mould to expand or move the aforesaid resin-diffusing medium, along with the aforesaid inner mould, in the outer mould direction, and

(F) A synthetic resin impregnation stage in which synthetic resin is injected into the aforesaid reinforcing fibre and the interior of the substrate is impregnated by uniform diffusion of the resin in the plane direction of the reinforcing fibre substrate.

Still another embodiment of the production method for the fibre-reinforced plastic structure with a hollow section according to the present invention is a method to produce fibre-reinforced plastic structures that have a non-circular

fibre-reinforced plastic structure with a hollow section that consists at least of the following stages from (A) to (D) which are carried out in this order:

(A) An inner mould preparation stage in which an inner mould with a cross-section having a non-circular sectional shape is fitted on a stand

(B) A substrate placement stage in which a substrate comprising in part or in total reinforcing fibre is placed on the surface of the aforesaid inner mould in such a manner that the substrate does not extend continuously around the inner mould over a length not less than two times the circumference,

(C) A pressure-reduction stage in which the top of the aforesaid substrate on the surface of the inner mould is covered over with a bag and the interior pressure of said bag is reduced to below atmospheric pressure, and

(D) A synthetic resin impregnation stage in which synthetic resin is injected into the aforesaid reinforcing fibre and the interior of the substrate impregnated by uniform diffusion of said resin in the reinforcing fibre substrate face direction.

Another embodiment of the production method for the fibre-reinforced plastic structure with a hollow section according to the present invention is a method for the production of a fibre-reinforced plastic structure with a hollow section that consists at least of the following stages from (A) to (F) which are carried out in this order:

cross-section and that are composed of a plurality of moulded elements, at least one of the aforesaid moulded elements having at least one opening and a main body portion containing a cavity in its interior, wherein when the aforesaid moulded elements are coupled together, said moulded elements are mutually joined together by placing reinforcing fibre to straddle the joint regions between the moulded elements, and then placing a bag to locally cover the joint regions from over the reinforcing fibre, followed by reducing the pressure in the bag to ensure resin injection and impregnation.

Brief Explanation of the Drawings

Figure 1 is a perspective view showing an example of a hollow FRP structure where the present invention can be applied.

Figure 2 is a perspective view showing another example of a hollow FRP structure where the present invention can be applied.

Figure 3 is a perspective view showing still another example of a hollow FRP structure where the present invention can be applied.

Figure 4 is a perspective view showing still another example of a hollow FRP structure where the present invention can be applied.

Figure 5 is a perspective view showing still another example of a hollow FRP structure where the present invention can be applied.

If, when arranging the substrate on the outer face of the inner mould the reinforcing fibre of the substrate extends for two or more laps of the circumference of the hollow inner mould, the pressure from the hollow inner mould is concentrated only in the reinforcing fibre and it is difficult to uniformly apply pressure to the structure as a whole. Moreover, by applying pressure to the interior, the hollow inner mould is made to expand radially and, furthermore, the reinforcing fibre also made to move a little to produce a slack-free state, so if the fibre extends for two or more laps then this movement will be impeded. As a result, the FRP structure may not be moulded to the desired shape and dimensions, and the escape of bubbles or the diffusion of resin may be inadequate, so that the characteristics of the FRP structure are not fully manifested. Consequently, it is necessary that arrangement of the substrate be carried out such that reinforcing fibre does not extend continuously for two or more circuits of the hollow inner mould, that is to say it does not extend continuously over two or laps of the circumference of the interior space of the hollow FRP structure. Now, reference here to the arrangement being carried out such that it does not extend continuously for two or more laps, means that at least 80 vol% (more preferably 90 vol% and still more preferably 95 vol%) of the reinforcing fibre in the FRP does not extend continuously for two or more laps, and it is not intended to exclude the case where even one reinforcing fibre extends continuously over two or more laps.

Furthermore, the hollow FRP structure preferably has parts which are integrally moulded over the entire circumferential direction length. Such parts integrally moulded over the entire circumferential direction length need not necessarily

curing temperature. In particular, it is preferred that the heat resistance temperature be at least 5°C higher than the resin curing temperature or the provisional curing temperature, in that it is possible to suppress distortion of the inner mould during the resin curing or provisional curing and the dimensional accuracy of the structure can be ensured. Now, the heat resistance of the inner mould is defined by the Vicat softening point measured in accordance with JIS-K6760.

The hollow FRP structure of the present invention can be produced via at least the following stages (A) to (D) in turn.

(A) An inner mould preparation stage in which an inner mould with a cross-section having a non-circular sectional shape is fitted on a stand

(B) A substrate placement stage in which a substrate comprising in part or in total reinforcing fibre is placed on the surface of the aforesaid inner mould in such a manner that the substrate does not extend continuously around the inner mould over a length not less than two times the circumference,

(C) A pressure-reduction stage in which the top of the aforesaid substrate on the surface of the inner mould is covered over with a bag and the interior pressure of said bag is reduced to below atmospheric pressure, and

(D) A synthetic resin impregnation stage in which synthetic resin is injected into the aforesaid reinforcing fibre and the interior of the substrate impregnated by uniform diffusion of said resin in the reinforcing fibre substrate face direction.

It is preferred that there be added to these stages a stage in which the entire body is cured in the temperature range of 50 to 200°C to form an integral-moulded body.

The hollow FRP structure of the present invention can also be produced by at least the following stages (A) to (F) which are carried out in this order:

(A) An inner mould preparation stage in which a hollow inner mould having a non-circular cross-section and made of flexible material is fitted on a stand,

(B) A resin-diffusing medium placement stage in which a resin-diffusing medium that allows resin to diffuse within it is placed over at least part of the outside surface of the aforesaid inner mould,

(C) A substrate placement stage in which a substrate comprising in part or in total reinforcing fibre is placed on the surface of the aforesaid inner mould,

(D) An outer mould placement stage in which the outer periphery of the aforesaid substrate that has reinforcing fibre on it is covered with an outer mould,

(E) A pressure-reduction stage in which the pressure is reduced in the space between the aforesaid outer mould and the inner mould to expand or move the aforesaid resin-diffusing medium, along with the aforesaid inner mould, in the outer mould direction, and

(F) A synthetic resin impregnation stage in which synthetic resin is injected into the aforesaid reinforcing fibre and the interior of the base material impregnated by uniform diffusion of the resin in the reinforcing fibre substrate face direction

In such circumstances it is preferred that at least a part of the outer face of the inner mould be covered with a sheet-shaped covering material, and on top of this there is arranged the substrate comprising reinforcing fibre in part or in total, after which covering is performed from the outer periphery thereof with the outer mould, and then the region between said outer mould and inner mould reduced in pressure, and synthetic resin injected in a state with the aforesaid covering material expanded or caused to move in the direction of the outer mould and, by allowing said resin to diffuse through the reinforcing fibre substrate in the face direction, the interior of the reinforcing fibre substrate is impregnated with the resin.

In both the aforesaid production methods, it is preferred that there be used a hollow inner mould, that there be used an inner mould with resin flow channel grooves in the outer face, and that the synthetic resin be injected into the reinforcing fibre base material from said grooves.

In the latter production method, it is preferred that there be used an inner mould comprising an elastic material, that the interior of the inner mould be pressured with a fluid and said inner mould caused to expand in the direction of the outer mould, and that the fluid used for the internal pressurizing of the inner mould in such circumstances be compressed air, the pressure of which preferably lies in the

(F) A synthetic resin impregnation stage in which synthetic resin is injected into the aforesaid reinforcing fibre and the interior of the base material impregnated by uniform diffusion of the resin in the reinforcing fibre substrate face direction

In such circumstances it is preferred that at least a part of the outer face of the inner mould be covered with a sheet-shaped covering material, and on top of this there is arranged the substrate comprising reinforcing fibre in part or in total, after which covering is performed from the outer periphery thereof with the outer mould, and then the region between said outer mould and inner mould reduced in pressure, and synthetic resin injected in a state with the aforesaid covering material expanded or caused to move in the direction of the outer mould and, by allowing said resin to diffuse through the reinforcing fibre substrate in the face direction, the interior of the reinforcing fibre substrate is impregnated with the resin.

In both the aforesaid production methods, it is preferred that there be used a hollow inner mould, that there be used an inner mould with resin flow channel grooves in the outer face, and that the synthetic resin be injected into the reinforcing fibre base material from said grooves.

In the latter production method, it is preferred that there be used an inner mould comprising an elastic material, that the interior of the inner mould be pressured with a fluid and said inner mould caused to expand in the direction of the outer mould, and that the fluid used for the internal pressurizing of the inner mould in such circumstances be compressed air, the pressure of which preferably lies in the

range 0.05 to 1.0 MPa (0.5 to 10 kgG/cm^2) and more preferably 0.1 to 0.5 MPa.

Again, in each of the aforesaid production methods it is preferred that, in the substrate arrangement stage (B), there be used a resin diffusion medium which enables resin to diffuse into the covering material, and that this medium be a reticulate material. As the inner mould a plastic, rubber material, water-soluble polymer material or wood is preferably employed, the former being more preferred, and it is preferred that it be moulded in the form of a hollow body by the blow moulding method. ~~Again, in aforesaid substrate arrangement stage (B), when~~ arranging the substrate comprising reinforcing fibre, it is preferred that there be used, between substrates and/or between substrate and inner mould a substrate retainer which secures the substrate. It is preferred that moulded elements be integrally coupled by joining together by means of a local moulding method.

Furthermore, in each of the production methods, it is preferred that there either be added an inner mould removal stage for removing the inner mould from the integrally-moulded structure, or that the inner mould be left in the integrally-moulded structure as an integral part of the structure.

When producing a fibre-reinforced plastic structure composed of a plurality of moulded elements, at least one of which moulded elements has a solid of non-revolution shape section and is provided with at least one opening and a main body portion having a cavity in the interior, at the time of the coupling together of these moulded elements said moulded ~~elements can be mutually joined together by arranging~~

Scope of Claims

1. (corrected) A fibre-reinforced plastic structure with a hollow section which is characterized in that

(A) it is a fibre-reinforced plastic structure with a hollow section which is provided with at least one opening and with a main body portion having in the interior a cavity of maximum width greater than the maximum width of the aforesaid opening(s),

(B) the aforesaid main body portion is composed of fibre-reinforced plastic where reinforcing fibre has been impregnated with synthetic resin and, furthermore,

(C) the aforesaid main body portion has a solid of non-revolution shape where the interior maximum width (F) of the cavity is at least 0.5 m and the ratio (F/f) of the interior maximum width (F) of the cavity to the maximum width (f) of the aforesaid opening(s) lies in the range 1.1 to 500,

(D) furthermore, the aforesaid main body portion is formed as an integral construction in which its totality substantially has no regions which are joined, and

(E) the reinforcing fibre for the aforesaid main body portion does not virtually extend continuously in the circumferential direction around the portion over a length not less than two times the circumference.

2. A fibre-reinforced plastic structure with a hollow section according to Claim 1 which is characterized in that, at the inner circumferential face of the aforesaid main body

portion, there is a projecting rib which projects in the radial direction thereof.

3. A fibre-reinforced plastic structure with a hollow section according to Claim 2 which is characterized in that the aforesaid projecting rib has a frame structure with a core material present in the interior and, furthermore, with the periphery of the core material enveloped by a skin layer containing reinforcing fibre.

4. (deleted)

5. (corrected) A fibre-reinforced plastic structure with a hollow section according to any of Claims 1-3 which is characterized in that the foresaid portion whose cross section in the circumferential direction forms a closed space and that is formed as an integral construction substantially having no joined regions,

6. (deleted)

7. (corrected) A fibre-reinforced plastic structure with a hollow section which is characterized in that

(A) it is composed of a plurality of moulded elements,

(B) at least one of these moulded elements is a structure which is provided with at least one opening and with a main body portion having a cavity in the interior and, furthermore, the section thereof has a solid of non-revolution shape,

(C) the aforesaid opening is located at an end of the structure composed of a plurality of moulded elements,

(D) the maximum internal width of the aforesaid hollow section, (F), is not less than 0.5 m, and the ratio (F/f) of the maximum internal width of the hollow section, (F), to the maximum width of the aforesaid opening ,(f), is in the range of 1.1 to 500.

(E) the aforesaid main body portion is made of fibre-reinforced resin produced by impregnating reinforcing fibre with synthetic resin,

(F) the aforesaid main body portion has in at least one location a portion forming a closed space in the circumferential direction section and which is formed as an integral construction substantially having no joined regions, and

(G) the reinforcing fibre for the aforesaid main body portion does not virtually extend continuously in the circumferential direction around the portion over a length not less than two times the circumference.

8. (deleted)

9. (deleted)

10. (corrected) A fibre-reinforced plastic structure with a hollow section according to Claim 7 which is characterized in that at the inner surface facing the cavity of the aforesaid structure, there is a rib projecting in the radial direction thereof.

11. (corrected) A fibre-reinforced plastic structure with a hollow section according to Claim 10 which is characterized in that the aforesaid projecting rib has a frame structure with a core material present in the interior and the periphery thereof enveloped by a skin layer containing reinforcing fibre.

12. (corrected) A fibre-reinforced plastic structure with a hollow section according to any of Claims 1-3, 5, 7, 10, and 11 which is characterized in that the main body portion of the aforesaid structure is formed with a shell comprising aforesaid skin layer positioned on the outside and core material positioned on the inside.

13. (corrected) A fibre-reinforced plastic structure with a hollow section according to Claim 12 which is characterized in that the aforesaid structure is formed with a shell where skin layer comprising fibre-reinforced plastic is further laminated on the inside of the aforesaid core material.

14. (corrected) A fibre-reinforced plastic structure with a hollow section according to Claims 12 or 13 which is characterized in that the aforesaid core material has a rib which extends in the radial direction of the structure.

15. (corrected) A fibre-reinforced plastic structure with a hollow section according to any of Claims 3 and 11-14 which is characterized in that the aforesaid core material comprises a foam.

16. (corrected) A fibre-reinforced plastic structure with a hollow section according to any of Claims 3 and 11-15 which

is characterized in that a groove is formed in the surface of the aforesaid core material.

17. (corrected) A fibre-reinforced plastic structure with a hollow section according to any of Claims 1-3, 5, 7, and 10-16 which is characterized in that a liner is provided in at least one part of the inner face of the aforesaid main body portion.

18. (corrected) A fibre-reinforced plastic structure with a hollow section according to Claim 17 which is characterized in that the aforesaid liner has a plurality of concave grooves.

19. (corrected) A fibre-reinforced plastic structure with a hollow section according to any of Claims 1-3, 5, 7, and 10-18 which is characterized in that the aforesaid reinforcing fibre is at least one type from amongst carbon fibre, glass fibre, aramid fibre, high density polyethylene fibre and polyarylate fibre.

20. (corrected) A fibre-reinforced plastic structure with a hollow section according to any of Claims 1-3, 5, 7, and 10-19 which is characterized in that the aforesaid reinforcing fibre comprises carbon fibre tow, where one tow has a number of single filaments in the range 12,000 to 200,000.

21. (corrected) A fibre-reinforced plastic structure with a hollow section according to any of Claims 1-3, 5, 7, and 10-20 which is characterized in that the void content of the aforesaid main body portion lies within the range 2% and below, by volume.

22. (corrected) A fibre-reinforced plastic structure with a hollow section according to any of Claims 1-3, 5, 7, and 10-21 which is characterized in that the aforesaid synthetic resin is at least one type from amongst epoxy resins, unsaturated polyester resins, vinyl ester resins and phenolic resins.

23. (corrected) A fibre-reinforced plastic structure with a hollow section according to any of Claims 1-3, 5, 7, and 10-22 which is characterized in that a covering layer is integrally formed at the outer face of the main body portion.

24. (corrected) A fibre-reinforced plastic structure with a hollow section according to Claim 23 which is characterized in that the covering layer is a gel coat layer.

25. (corrected) Transportation equipment comprising, in part, a fibre-reinforced plastic structure with a hollow section according to any of Claims 1-3, 5, 7, and 10-24.

26. (corrected) An automobile comprising, in part, a fibre-reinforced plastic structure with a hollow section according to any of Claims 1-3, 5, 7, and 10-24.

27. (corrected) An airplane comprising, in part, a fibre-reinforced plastic structure with a hollow section according to any of Claims 1-3, 5, 7, and 10-24.

28. (corrected) A method for the production of a fibre-reinforced plastic structure with a hollow section that consists at least of the following stages from (A) to (D) which are carried out in this order:

(A) An inner mould preparation stage in which an inner mould with a cross-section having a non-circular sectional shape is fitted on a stand

(B) A substrate placement stage in which a substrate comprising in part or in total reinforcing fibre is placed on the surface of the aforesaid inner mould in such a manner that the substrate does not extend continuously around the inner mould over a length not less than two times the circumference,

(C) A pressure-reduction stage in which the top of the aforesaid substrate on the surface of the inner mould is covered over with a bag and the interior pressure of said bag is reduced to below atmospheric pressure, and

(D) A synthetic resin impregnation stage in which synthetic resin is injected into the aforesaid reinforcing fibre and the interior of the substrate impregnated by uniform diffusion of said resin in the reinforcing fibre substrate face direction.

29. (deleted)

30. (deleted)

31. (deleted)

32. (corrected) A method for the production of a fibre-reinforced plastic structure with a hollow section according to Claim 28 which is characterized in that the entire

structure is also cured within the temperature range 50 to 200°C, and integral moulding effected.

33. (corrected) A production method for a fibre-reinforced plastic structure with a hollow section that consists at least of the following stages from (A) to (F) which are carried out in this order:

(A) An inner mould preparation stage in which a hollow inner mould having a non-circular cross-section and made of flexible material is fitted on a stand,

(B) A resin-diffusing medium placement stage in which a resin-diffusing medium that allows resin to diffuse within it is placed over at least part of the outside surface of the aforesaid inner mould,

(C) A substrate placement stage in which a substrate comprising in part or in total reinforcing fibre is placed on the surface of the aforesaid inner mould,

(D) An outer mould placement stage in which the outer periphery of the aforesaid substrate that has reinforcing fibre on it is covered with an outer mould,

(E) A pressure-reduction stage in which the pressure is reduced in the space between the aforesaid outer mould and the inner mould to expand or move the aforesaid resin-diffusing medium, along with the aforesaid inner mould, in the outer mould direction, and

(F) A synthetic resin impregnation stage in which synthetic resin is injected into the aforesaid reinforcing fibre and

the interior of the substrate is impregnated by uniform diffusion of the resin in the plane direction of the reinforcing fibre substrate.

34. (corrected) A method for the production of a fibre-reinforced plastic structure with a hollow section according to Claim 28 or 33 which is characterized in that, in the aforesaid pressure reduction stage, the inner mould interior is pressurized with a fluid and said inner mould made to further expand in the outer mould direction.

35. (deleted)

36. (corrected) A method for the production of a fibre-reinforced plastic structure with a hollow section according to Claim 34 which is characterized in that, in the aforesaid pressure reduction stage, the fluid used for pressurizing the interior of the inner mould is compressed air and the applied pressure thereof lies within the range 0.049 to 0.98 MPa (0.5 to 10 kg/cm^2G).

37. (corrected) A method for the production of a fibre-reinforced plastic structure with a hollow section according to Claims 28, 32-34, and 36 which is characterized in that, in the aforesaid inner mould preparation stage, an inner mould having resin channel grooves in the outer face is employed and the synthetic resin is injected into the reinforcing fibre substrate through said grooves.

38. (corrected) A method for the production of a fibre-reinforced plastic structure with a hollow section according to Claim 37 which is characterized in that the depth of said grooves is in the range of 1-50 mm.

39. (corrected) A method for the production of a fibre-reinforced plastic structure with a hollow section according to Claim 37 or 38 which is characterized in that the interval between said grooves is in the range of 5-900 mm.

40. (corrected) A method for the production of a fibre-reinforced plastic structure with a hollow section according to any of Claims 37-39 which is characterized in that the width of said grooves is in the range of 3-5 mm.

41. (corrected) A method for the production of a fibre-reinforced plastic structure with a hollow section according to Claim 33 which is characterized in that a reticulate material is used as resin diffusion medium in the aforesaid resin diffusion medium placement stage.

42. (corrected) A method for the production of a fibre-reinforced plastic structure with a hollow section according to any of Claims 28, 32-34, and 36-41 which is characterized in that a plastic, a rubber material, a water-soluble polymer material or a wood material is used as the aforesaid inner mould.

43. (corrected) A method for the production of a fibre-reinforced plastic structure with a hollow section according to any of Claims 28, 32-34, and 36-42 which is characterized in that the aforesaid structures are mutually joined together by a local vacuum moulding method to form a single body.

44. (added) A method for the production of a fibre-reinforced plastic structure with a hollow section according to any of Claims 28, 32-34, and 36-43 which is characterized

in that, in the aforesaid substrate arrangement stage, when arranging the substrate comprising reinforcing fibre, a substrate retainer which secures the substrate is provided between substrates or between the substrate and inner mould.

45. (added) A method for the production of a fibre-reinforced plastic structure with a hollow section according to any of Claims 28, 32-34, and 36-44 which is characterized in that an inner mould which is moulded as a hollow body by means of the blow moulding method is used.

46. (added) A method for the production of a fibre-reinforced plastic structure with a hollow section according to any of Claims 28, 32-34, and 36-45, which is characterized in that it has an inner mould removal stage in which the inner mould is removed from the integrally-moulded structure.

47. (added) A method for the production of a fibre-reinforced plastic structure with a hollow section according to any of Claims 28, 32-34, and 36-45 which is characterized in that the inner mould is integrally coupled to the structure and left within the integrally-moulded structure.

48. (added) A method for the production of a plurality *{sic}* of fibre-reinforced plastic structures with hollow sections which is characterized in that, it is a method for the production of a fibre-reinforced plastic structure composed of a plurality of moulded elements, at least one of which moulded elements has a section which constitutes a solid of non-revolution shape and which is provided with at least one opening and with a main body portion having a cavity in the interior,

and when joining together the aforesaid moulded elements, reinforcing fibre is arranged spanning the region of join between the moulded elements, and the regions of join are locally covered with bags from above the reinforcing fibre, after which the pressure inside the bags is reduced and resin injected, and impregnation effected, so that the moulded elements are mutually connected together.